

3.6.5. Navigation Performance in Overwater/Multipath Environment

3.6.5.1 Purpose

The purpose of this test is to assess the effects of satellite signal multipath upon the GPS system accuracy and utility.

3.6.5.2. General

The GPS satellite signal tends to reflect off of the surface of bodies of water. Typically, the smoother the surface, the better the surface will reflect. When an aircraft flies at low altitudes along the surface of the water, the aircraft will receive two signals from the GPS satellite, one sent directly from the satellite and the second sent from the satellite and then reflected off the surface of the water and thence directly to the aircraft. The reflected signal can interfere with the direct signal, causing the satellite quality numbers to become degraded and subsequently the total fix quality number also becomes degraded. The problem will vary with aircraft altitude above the surface; however, the effect will not normally be seen above 500 to 1,000 feet AGL. The multipath problem will also vary with the roughness of the water surface. The worst case will occur when the surface is smooth.

3.6.5.3. Instrumentation

A stop watch and data cards are required for this test, a voice recorder is optional. A properly instrumented range including highly accurate laser range or theodolite tracking is required. For the case where a laser ranger is used, a laser reflector array must be installed on the test aircraft.

3.6.5.4. Data Required

At altitude, note the satellites in use, satellite quality numbers and total fix quality number. Record the time, GPS-derived latitude and longitude and laser ranger or theodolite-derived latitude and longitude. After descending, note any times where the individual satellite quality numbers degrade. If low altitude fixes are required, record the elapsed time, altitude, GPS/INS displayed latitude and longitude, satellites used, satellite quality numbers, total fix quality number and laser or theodolite calculated latitude and longitude.

3.6.4.5. Procedure

Perform the test when the surface of the water in the vicinity of a space positioning range is as smooth as possible. This provides a worst case situation for satellite signal multipath. Begin the test at an altitude of at least 5,000 feet AGL with the GPS running alone. While minimizing maneuvers, note the satellite data, GPS position data and space positioning data.

Descend to the minimum altitude allowable considering the aircraft and qualifications of the test pilot. Usually 100 to 200 feet is sufficient. If possible, crew duties should be split to allow one person to fly the aircraft while the other collects data. Again, note the satellite data and compare to the previous satellites used and quality numbers. If the quality of the satellite signals are reduced notably, repeat the GPS position and space positioning data point. Repeat the low level portion of the test at 60° heading intervals. If multipath was noted with the P code installed, repeat the test with the P code not installed.

3.6.4.6. Data Analysis and Presentation

If the quality numbers are not degraded at low altitude, assume that the multipath effects are not present. If significant differences were noted, the additional space positioning data must be evaluated to determine the correlation between the degraded quality numbers and the actual degradation in positioning accuracy. For the data collected at the higher altitude, subtract the coupled GPS displayed latitude and longitude from the precise space positioning derived latitude and longitude. Convert the latitude and longitude difference to nm using equation (21). Repeat the procedure for the low level data at all headings where degradation was noted. Relate the degree of degradation to the necessity to perform low level navigation using GPS-derived data during attacks on shipping or during ingress and egress over the coastline.

3.6.4.7. Data Cards

Sample data cards are provided as card 53.

220

CARD NUMBER _____ TIME _____ PRIORITY L/M/H

PERFORMANCE IN OVERWATER/MULTIPATH ENVIRONMENT

[USE GPS ALONE WITH INS SET TO OFF. CLIMB TO _____ FT AGL AND SET _____ KIAS. MINIMIZE
MANEUVERING. NOTE SATELLITE DATA.]

P CODE: YES / NO

SATELLITES IN USE/QUALITY NUMBERS:

TOTAL POSITION QUALITY NUMBER _____

TIME _____ SPACE POSIT LAT/LONG _____ / _____

NOTES:

CARD NUMBER ____

PERFORMANCE IN OVERWATER/MULTIPATH ENVIRONMENT

[DESCEND TO ____ FT AGL AND SET ____ KIAS. MAINTAIN HEADING AND NOTE SATELLITE QUALITY NUMBERS AND IF DEGRADED. IF DEGRADED, NOTE REST OF DATA LISTED ON CARD.]

TIME	GPS LAT /LONG	SATELLITES/QUAL NUM	TOTAL QUAL NUM	HEADING	ALT	SPACE POSIT LAT/ LONG